Dog ecology studies
oral vaccination of dogs
Burden of rabies

By F.X. Meslin
Dog ecology technologies and techniques

1 Surveys
1.1 Preliminary Survey

Qualitative surveys to identify social and ecological determinants on the dog population size, structure and relationships to humans.

Accessibility of dogs to rabies control personnel and volunteers should be the first factor to be examined.

In small communities, where the majority of dogs is easily accessible, the ecological questionnaire survey and/or dog marking can be conducted simultaneously with vaccination campaigns.

In communities suspected of having dog accessibility problems, and in larger communities requiring operational research for planning, a formal survey should be carried out in randomly selected sample squares.
1.2 The main survey

A. Questionnaire survey and observation inventory

Interview of community leaders and a cross section of community members; obtaining the best census data (man and animals) and available maps of the area concerned;

Sampling techniques should be adapted to the study area. In villages of under 500 families, all households should be surveyed. In larger communities and cities, samples must be large enough to be statistically reliable.

Questionnaire surveys alone may lead to a preponderance of data concerning restricted and semi-restricted dogs.

In areas where relatively unrestrained dogs predominate, capture/recapture and dog accessibility studies will help to correct such biases.
Dog ecology technologies and techniques

- **B. Capture/recapture techniques and dog accessibility studies (visual techniques).**

- Mark dogs in about 500 neighboring households at vaccination and re-observed at subsequent intervals so as to assess unrestricted, semi-restricted, and restricted dogs.

- The proportion of marked/unmarked dogs may be used to estimate the dog population size.

- Note information on the sex ratio be noted and possibly be obtained on the extent of supervision (restricted, semi-restricted and whether owner is «nearby»). Puppies should be recorded in respect to litter size.
Categorization of individual dogs according to restriction and dependency on humans

Need for distinct nomenclature and clear definitions of dogs living in a variety of relationships with their human host population.

1 Level of dependence
Dependence describes a dog-man bond based on intentional provision of food, physical shelter, care and any other action to meet the social needs essential for the survival, propagation and well-being of the dog.
- Full dependency
- Semi-dependency
- No dependency

2 Level of restriction
« Under restriction » understood as all physical and biological types of restriction which a human intentionally imposes on a dog: i.e. movement restriction and confinement of a dog in human’s premises and supervision outside these premises. Also includes measures controlling the reproduction of dogs.
- Full restriction
- Semi-restriction
- No restriction
The matrix resulting from the two parameters described above permits a further reduction in the number of categories to possible and essential combinations of levels of care and supervision.

<table>
<thead>
<tr>
<th>1. FULL RESTRICTION</th>
<th>2. SEMI-RESTRICTION</th>
<th>3. NO RESTRICTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dog is physically separated from the rest of the population on a permanent basis</td>
<td>Dog has access to rest of the population some of the time</td>
<td>Dog has free access to the population at all times</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1. FULL DEPENDENCY</th>
<th>2. SEMI-DEPENDENCY</th>
<th>3. NO DEPENDENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>The dog is given all of its essential needs intentionally by Humans</td>
<td>The dog is given a proportion of its essential needs intentionally by Humans</td>
<td>The dog is given none of its essential needs intentionally by humans</td>
</tr>
</tbody>
</table>

**TABLE 1. DOG CATEGORIZATION MATRIX**

- **owned**
- **"stray"**
- **UNRESTRICTED DOG**
- **FERAL DOG**
WHO recommendations on oral vaccination of dogs
by F.X. Meslin
WHO, Geneva
WHO promotes studies on oral vaccination of dogs (OVD) recognizing the insufficiencies of the parenteral route for dog rabies elimination.

OVD offers new approaches promising a significant increase in the dog vaccination coverage (especially of free-roaming and poorly supervised dogs) both when applied exclusively or in combination with parenteral vaccination.
"size of target dog population"

*D og population size*

In most Asian countries 1 dog per every 7-10 inhabitants

- Sri Lanka: 1.5 to 2 million
- Thailand: 5.5 million
- Myanmar: 3.5 million
- India: 26 million
- China: up to 100 million!

*D og population turnover: 25 to 30% per year*
Parenteral vaccination of dogs

Tunisia

Parenterally vaccinated dogs (57%)

Protected 48%

- 12% (these dogs may be vaccinated orally)
- 21%
- 7%
- 2%

Not protected 9%

- 7% (low quality vaccines)
- 10% (immunity failure)
- 2% (other reasons)

Non parenterally vaccinated dogs (43%)

- 22% (owned dogs)
  - 21% (lack of motivation, lack of organization)
  - 7% (other reasons)
- 10% (ownerless dogs)

- 9% (difficulty to handle)

Ownerless dogs

- 22%
Dog population structure

Structures of dog populations of Africa & Asia (in %)

- 100 %
- 5 -15 %
- 80 - 60 %

- Ownerless
- Owned & unaccessible
- Owned & accessible

TUN TURYEM
Oral vaccination of dogs

comparison of Oral versus parenteral vaccination of owned dogs (in rural Mexico*):

<table>
<thead>
<tr>
<th>oral bait consumed</th>
<th>yes</th>
<th>no</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes</td>
<td>115 (52%)</td>
<td>34 (15%)</td>
<td>149 (67%)</td>
</tr>
<tr>
<td>no</td>
<td>43 (19%)</td>
<td>32 (14%)</td>
<td>74 (33%)</td>
</tr>
<tr>
<td>total</td>
<td>158 (71%)</td>
<td>66 (29%)</td>
<td>223 (100%)</td>
</tr>
</tbody>
</table>

(* By D.B. Fishbein, 1992)
Oral vaccination of dogs

- bait acceptance by free-roaming dogs*(Tunisia)

*by H.Matter, 1991
Oral vaccination of dogs

Potential of Oral versus Parenteral Vaccination according to population structure

Proportion of owned dogs (accessible and not)

Immunization coverage:
- Oral vaccination combined or not with PV
- Parenteral vaccination

- Ownerless
- Owned & unaccessible
- Owned & accessible
Why should oral vaccines for dogs be safer than vaccines used for wildlife

- Dogs are very closely associated with humans, especially with children, in a majority of cultures. Non-routine activities vaccination of dogs draw much attention from the public and interference of humans with baits has to be expected.

- The likelihood of direct exposure and of passive vaccine virus transfer to humans is considerably higher for oral dog vaccination than for wildlife immunization programs.
WHO study Protocols for testing and comparing of different bait distribution systems

- 4 delivery systems for OVD:

  - Door to door
  - Distribution of the baits to owned dogs via their owner who would collect the bait at a central location,
  - Placement of baits at selected sites where they were accessible to free-roaming dogs (so-called « wildlife immunization model ») and
  - Distribution of baits to owned or ownerless dogs encountered in the street (so-called « hand-out model »).
Hand-out bait distribution:

1- Hand 1 bait out to each dog

2- Collecting unconsumed bait

- limits:  
  - time-consuming thereby costly
  - no risk of human contact with the vaccine
  - limited number of dogs can be reached in a given period of time

- advantage: reach part of an important sub component of the dog population
Bait distribution to dog owners in a bait distribution centre

- limits: requires owners’ awareness and participation
- benefits: does not require bringing dogs along to a vaccination point
- disadvantages: - distribution to dogs and consumption cannot be checked
  - higher risk of human contact with the vaccine
Bait distribution according to the wildlife immunisation model

- high cost: large number of baits per vaccinated dog
- higher risk of human contacts with the vaccine
- may not be well accepted by local population
Most appropriate bait and bait delivery systems in a given area are determined by:

- SAFETY for other than dog animal species and human
  - bait acceptance rates by target and non-target species,
  - socio-cultural acceptance,
  - efficacy of the delivery system
  - economics associated with program implementation, and
Recommendations for the implementation of oral vaccination projects

The first steps of a national strategy could be:

- to select one or several candidate vaccines.
- to choose an already available bait or to develop a new one.
- to evaluate the acceptability of the chosen bait(s) in the target population;
- to conduct dog population studies to better define the target populations for parenteral and oral immunization.
- To estimate vaccination coverage established in a given community by oral and parenteral immunization and study the economics of oral and parenteral immunization.
- Before undertaking any field trial, to provide sufficient information to the public so that, in general, public support and cooperation is elicited;
Need for a better rabies burden assessment:

WHO initiated work for the development of a global model for the re-assessment of rabies public health and economic burden in Africa and Asia.

We used the model developed by S. Cleaveland

Main parameters driving the model are

- Annual incidence of suspect rabid dog bites
- ‘Rabies recognition probability’ $P_1$
- Probability of receiving successful post-exposure treatment $P_{10}$

- Each parameter: a variable for which we have defined their is a minimum, a likely and a maximum value. Or a point probability
- For incidence of dog bites: from 10 to 250 per 100 000 most likely 100
- For $P_1$: 39% to 64% most likely 50%
- For $P_{10}$: 55% to 100% most likely 60 to 80%
Probability tree: development of clinical rabies after a suspect rabid dog bite

P_{\text{death}} = P_1 \times [(P_2 \times P_6) + (P_3 \times P_7) + (P_4 \times P_8) + (P_5 \times P_9)] \times (1 - P_{10})
Global outputs:

Human Deaths: 55,000

Total Asia: 31,000 (56% of total)
  US$ burden: $560 millions
  9 over 10 deaths in rural areas

Total Africa: 24,000 (44% of total)
  Total Africa: 20 (3.5%)
  3 over 4 deaths in rural areas
Evaluating the burden of rabies

- Collect information on suspect dog bites
- Determine P1 probability of a specimen to be found positive in the laboratory
- and P10 probability of getting effective PEP.